ICS Impulse Interpretation Guide

A guide to reducing artifacts and collecting quality data

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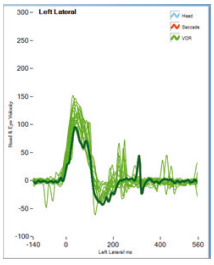
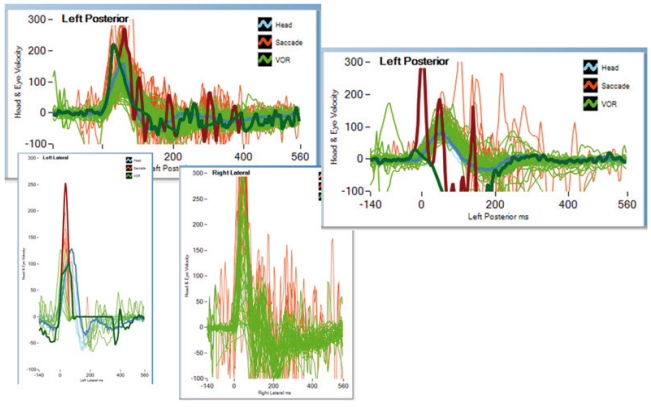
Some *images courtesy of Kamran Barin, Ian Curthoys, and Leigh McGarvie*

Methodology	Collection	Example
Artifact 1 Poor Pupil Detection	In order for the ICS Impulse to properly collect data it must track the patient's pupil. Poor pupil detection will result in noisy, uninterpretable data. This is within your control, make your test environment as perfect as possible. • Clean fingerprints off of mirror and dust off of the camera lens. • Make sure the pupil is in the center of the ROI box and pupil detection threshold is set so that the pupil is located. • Test in a normally lit room but make sure there are no reflections from a light source on the mirror. • Watch the pupil during testing and make sure the patient is staring at the fixation dot. • The pupil should not touch the edge of the ROI box if this is happening your head impulse amplitude is too large (above 250 deg/sec). • Do not push down on the patient's head when performing the head impulse, this causes eye blinks. • Flat lines are caused by eye being closed or pupil moving out of the ROI box.	**Good Pupil Detection**  **Poor Pupil Detection**  For more information on Artifacts please read: Mantokoudis G, Saber Tehrani AS, Kattah JC, Eibenberger K, Guede CI, Zee DS & Newman-Toker DE Quantifying the Vestibulo-ocular reflex with Video-oculography: Nature and Frequency of Artifacts. Audiol Neuro-otol 2015; 20(1):39-50. Doi:10.1159/000362780.

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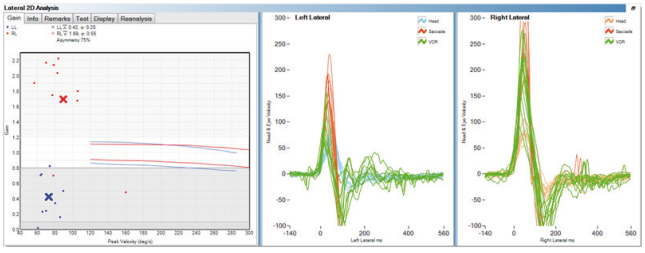
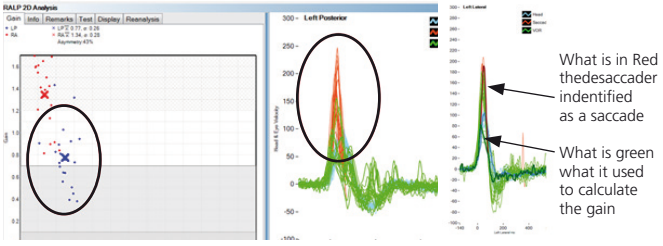
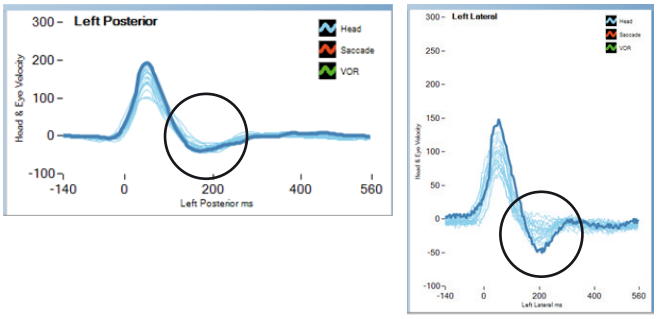
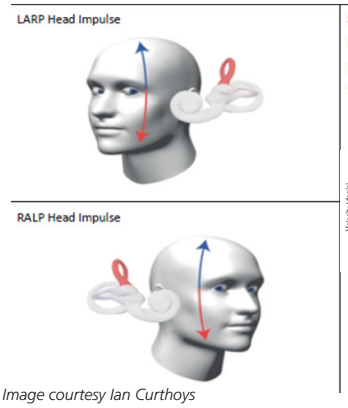
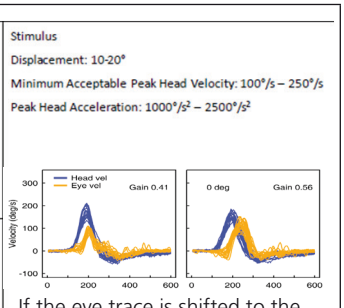
Artifact 2 Eye leading the head	If the eye is leading the head, it is most likely due to improper goggle fit. This will result in inaccurate gain values either too high or too low • Use a new face cushion • Tighten the goggle strap • Clip the cable to the patient's right shoulder • Do not touch the strap or goggles during testing • Touching the goggle can result in multiple peaks in the data and make it uninterpretable • Fixation dot must be 1 meter or greater from the patient • Make sure you performed a calibration check and calibration was good	 What is causing the abnormal low gains? The eye movement looks like a saccade because the slope of the eye movement is so steep on the right side and it looks like a peak. The desaccader is removing it and then calculating the area under the curve resulting in a low gain. The data can be corrected using reanalysis but it still is not accurate and should not be interpreted. 
Artifact 3 Overshoot	Overshoot is when you do a head impulse in one direction (e.g. leftward) and then quickly bring the head back in the opposite direction (e.g. rightward). This is a problem because both the left and right side are being stimulated. The side you are testing is not being isolated therefore you cannot determine a unilateral weakness. What is needed is a dead stop after the head impulse is performed.The operator feedback tells you if overshoot is occurring. Overshoot can also cause catch-up saccades in the opposite direction.	**Good Head Impulse** **Overshoot** 
Artifact 4 Wrong Planes Stimulated	During LARP/RALP, the head should be turned 35-45 degrees and the patient should be looking back at the fixation dot. The head impulse should be performed in the plane of the canals being tested, NOT toward the nose. When you perform the head impulse toward the nose you are stimulating both sides. You want to isolate the canals you are testing (e.g. left anterior/right posterior). *Leigh A. McGarvie, Marta Martínez López, Ann M. Burgess, Hamish G. MacDougall & Ian S. Curthoys Horizontal eye position affects measured vertical VOR gain on the video Head Impulse Test Frontiers in Neurology http://journal.frontiersin.org/article/ISSN: 1664-2295*	 *Image courtesy Ian Curthoys*  If the eye trace is shifted to the right of the head trace, the head impulse was directed toward the nose. This is wrong. *Image courtesy of Leigh McGarvie.*

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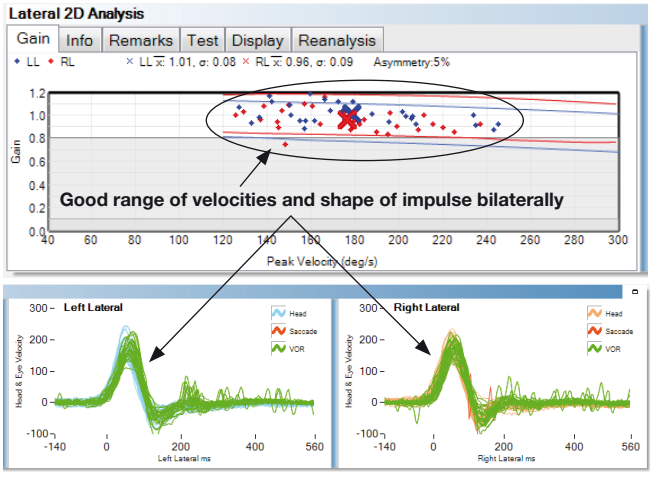
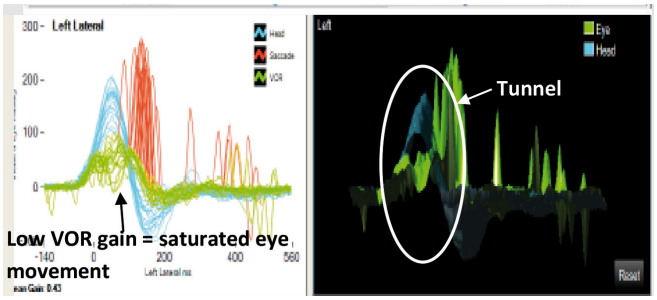
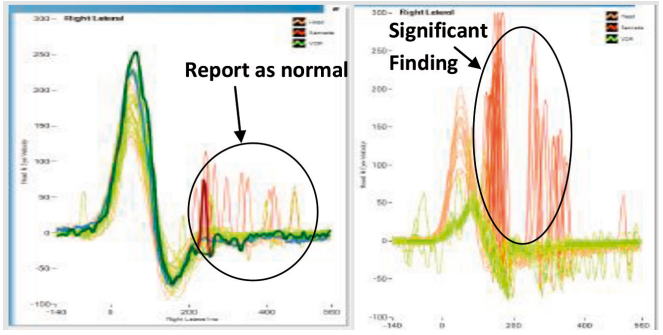
Methodology	Data Review	Example
Step 1 Determine the shape of head velocities	Check you have performed good head impulses. The best way to do this is to look at the shape of the head movement and spread of impulses plotted on the gain graph. Bilaterally you should have a similar good range of velocities between 120-250°/sec for Lateral and 100-200°/sec for LARP/RALP.	
Step 2 Determine the shape of head velocities	If the vestibular reflex is intact the eye velocity should be proportional to the head movement. If the eye movement looks saturated or clipped you may see a 'tunnel' between the head and the eye trace. You can normally see this more clearly in the 3D graph.	
Step 3 Catch - up Saccade	If catch up saccades are present, for them to be significant they should be large in amplitude, consistent across many of the head impulses you perform and they cannot occur any earlier than 70ms. In the Otosuite V 2.0 software and newer, true catch-up saccades will be red, if the algorithm determines they are significant. Some small saccades can occur in patients with normal vestibulo-ocular reflex.	

References for further information:

1) Chen L, Todd M, Halmagyi GM Aw S. Head impulse gain and saccade analysis in pontine cerebellar stroke and verstibular neuritis. Neurol 2014;83:10-21.

2) MacDougall HG, Weber KP, McGarvie LA, Halmagyi GM, Curthoys IS (2009) The video head impulse test: Diagnostic accuracy in peripheral vestibulopathy. Neurology 73 (14): 1134-1141.

3) MacDougall HG, McGarvie LA, Halmagyi GM, Curthoys IS, Weber KP The Video Head Impulse Test (vHIT) Detects Vertical Semicircular Canal Dysfunction. PLOS One, 2013 April Vol 8:4; e61488

4) Weber KP, Aw ST, Todd MJ, McGarvie LA, Curthoys IS, Halmagyi GM. Head impulse test in unilateral vestibular loss: vestibulo-ocular reflex and catch-up saccades. Neurology 2008; 70(6):454-463.

5) Weber KP, MacDougall HG, Halmagyi GM, Curthoys IS. Impulsive testing of semicircular canal function using video-oculography. Annals of the New York Academy of Sciences, 2009; 1164: 486-491.

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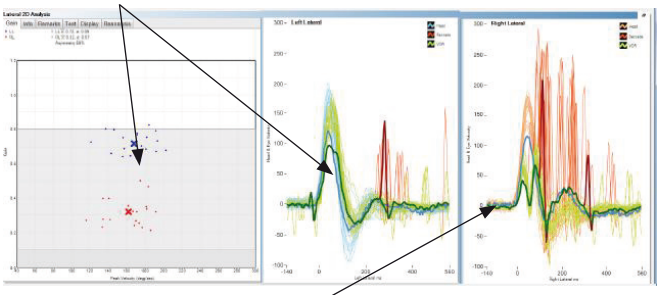
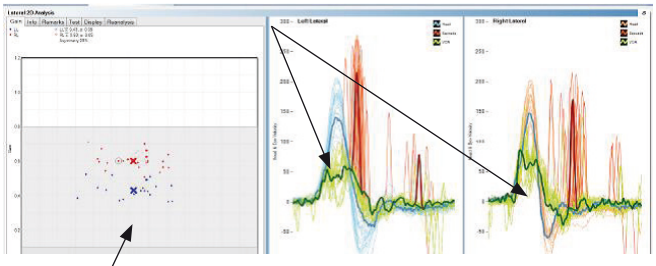
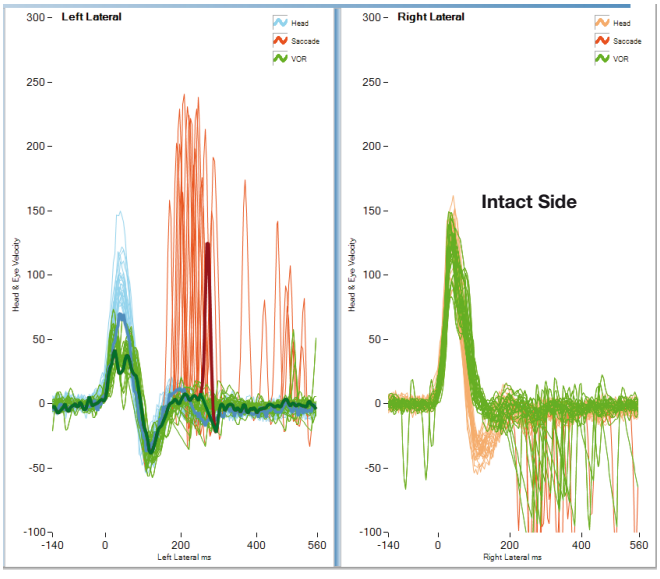
Methodology	Data Review	Example
Step 4 VOR Gain	Normative values in the ICS Impulse for VOR gain are as follows: Lateral impulse is 0.8-1.2 and for LARP and RALP is 0.7-1.2. If VOR gain is higher than this it is usually artefact. Be aware as some unilateral weaknesses may reduce the VOR gain in both ears so refer back to the eye movement trace to confirm whether unilateral or bilateral weakness.	**Unilateral loss: Left normal -Low gain but good eye velocity**  **Right deficit - Saturated eye velocity** **Bilateral Weakness – Bilateral saturated eye velocity**  **Bilateral Low VOR**
Step 5 Spontaneous Nystagmus	Unlike catch-up saccades spontaneous nystagmus may occur before and/or after the head impulse and are usually smaller in amplitude than catch-up saccades. You will normally see them going upward in one impulse direction and downward in the other. For nystagmus that beats away from the side of lesion, spikes appear in the opposite direction of VOR eye movements following head impulses toward the intact side. Be aware that overshoot can also cause saccades in the opposite direction and look like spontaneous nystagmus. *MacDougal HG, Weber KP et al (2009) The Video Head Impulse Test: Diagnostic accuracy in peripheral vestibulopathy. Neurology 73:1134:1141*	

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